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ABSTRACT

A series of experiments explored the feasibility of substituting listening for reading requirements in Army training and jobs, with special reference to marginally literate, AFQT Mental Category IV men. Results of these experiments and related earlier research are summarized. Major findings indicate that high and low aptitude men may learn certain materials as well by listening as by reading; some poorer readers prefer to learn by listening rather than by reading. Characteristics of the recorded message that were found to affect listening comprehension include difficulty level of message, linguistic features of speech, and rate of speech. Extensive studies of the use of time-compressed and expanded recordings are described. (Author)

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Technical Report 71-5

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Learning by Listening in Relation to Aptitude, Reading, and Rate-Controlled Speech: Additional Studies

Thomas G. Sticht

HUMAN RESOURCES RESEARCH ORGANIZATION
300 North Washington Street • Alexandria, Virginia 22314

April 1971

Prepared for

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OFFICE OF EDUCATION
400 MARYLAND AVE. S.W.
WASHINGTON, D.C. 20202

1. This is the second report describing a series of experiments that explore the feasibility of substituting learning by listening for learning by reading, a problem of special concern in situations where demands for reading exceed the reading skill of personnel. The first report was published as HumRRO Technical Report 69-23, December 1969.

2. Five experiments were carried out to explore the possible substitution of listening for reading requirements in Army training and jobs. Results of these experiments and related earlier research are summarized. Major findings indicate that high and low aptitude men may learn certain materials as well by listening as by reading. Some poorer readers prefer to learn by listening rather than by reading, which might provide significant motivation to study for many lower aptitude men. Moderate degrees of speech compression may improve the listening efficiency of men of high, average, and low aptitudes.

3. This report should be of interest to those concerned with training research and with the training of personnel with low literacy capabilities.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

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16. Abstract

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FOREWORD

The research reported herein was undertaken by the Human Resources Research Organization as a part of Work Unit REALISTIC, which considers methods for reducing literacy requirements for military training or job performance. This is the second report describing a series of experiments that explore the feasibility of substituting learning by listening for learning by reading, a problem of special concern for situations in which the demands for reading exceed personnel reading skill. The earlier report was *Learning by Listening in Relation to Aptitude, Reading, and Rate-Controlled Speech*, HumRRO Technical Report 69-23, December 1969.

The research was conducted at HumRRO Division No. 3, Presidio of Monterey, California, where Dr. Howard H. McFann is Director.

Military support was provided by the U.S. Army Training Center Human Research Unit. Successive military chiefs of the Unit throughout the duration of this research were LTC David S. Marshall, LTC Robert Emswiler, and LTC Ullrich Hermann.

The research was carried out by Dr. Thomas G. Sticht with the assistance of Mr. Lynn Fox, Mr. Harry Burckhartt, and Mrs. Rachel Chisum. Military assistants were SP5 James P. Ford and PFC Richard L. Ferrington.

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Meredith P. Crawford
President
Human Resources Research Organization

SUMMARY AND CONCLUSIONS

MILITARY PROBLEM

With the initiation of Project 100,000, substantial numbers of men who are ill-prepared in literacy skills are being accessioned into the Armed Services. To effectively assimilate these men into jobs, information is needed concerning the literacy demands of different types of work. Research is needed to explore methods for reducing discrepancies between literacy demands of jobs and the literacy skills of the manpower available to do the jobs.

RESEARCH PROBLEM

One method of adapting training or job requirements to accommodate men with deficient reading skills is to remove the reading requirement where feasible. This report extends previous research concerned with the possibility of substituting or supporting reading materials with listening materials where feasible, thereby removing one of the obstacles likely to be encountered by the marginally literate man.

APPROACH

The first study (Part I) was concerned with possible preference for learning by listening as opposed to learning by reading as a function of reading ability. If some men prefer learning by listening rather than by reading, they might be motivated to study if listening materials were made available.

In Part II the factors influencing learning by listening are examined in a series of five experiments. Experiment 1 determined whether observed limitations in the ability of men of different aptitude levels to comprehend very rapid rates of speech were due primarily to signal distortions resulting from the process used to accelerate the speech, or to the rate of speech itself.

Experiment 2 was concerned with the scaling of reading passages along a difficulty continuum from least to most difficult, so that these materials could be used as listening selections of known difficulty levels.

Experiments 3 and 4 then examined learning by listening as a function of the difficulty of different listening selections, the difficulty of materials within sentences of a listening selection, speech rate, and mental aptitude.

Experiment 5 attempted to improve the amount of learning by listening in a fixed amount of time by means of the time compression of speech.

RESULTS

Regarding the comparisons of preference for learning by listening versus learning by reading, the results indicated that:

(1) Preference for learning by listening ranged from 14% for men having high reading abilities to 45% for men with poor reading capability.

(2) Preference for learning by listening is also related to AFQT—ranging from 8% for Mental Category I men to 28% for Mental Category IV men.

(3) Overall, some 25% of a sample of 300 men preferred to learn by listening rather than by reading.

The results of the studies using time-compressed speech indicated that:

(1) Speech rate rather than signal distortion due to the compression process appears to be the major cause for decreased comprehension of materials presented at fast rates of speech; this was true for both high and low mental aptitude men.

(2) The scaling of reading passages for difficulty by direct magnitude estimation and a readability formula correlated highly with scaling of these materials by other researchers using Cloze procedures, recall tests, and category scaling techniques.

(3) Comprehension of listening passages decreased as a function of mental aptitude, and the difficulty level and speech rate of the listening selection. This was true for difficulty both between and within listening materials. No differences were found in the type of information learned by high and low mental aptitude men, although the latter learned a lesser amount from a listening selection.

(4) Using the time saved by the time compression of speech to present additional new information did not increase the amount learned over that obtained by presenting less information in uncompressed format.

CONCLUSIONS

The results of these studies, considered along with previous results from Work Unit REALISTIC, suggest that:

(1) Listening is an important training and job performance skill which predicts "hands-on" job sample performance test results as well as do reading test scores or AFQT. Consideration of listening ability tests for selection purposes is therefore suggested.

(2) Many men of low reading ability prefer to learn by listening, and they can be expected to learn many kinds of prose materials as well by listening as by reading. Hence, the provision of listening materials as well as reading materials in training and job situations may provide significant motivation to study for many lower aptitude men.

(3) Moderate degrees of speech compression may improve the listening efficiency (amount learned per time spent listening) of men of high, average, and low aptitudes.

(4) Because listening efficiency may improve with the use of time-compressed speech, the time saved might be used to improve learning by focusing attention through the use of inserted questions or by selectively emphasizing certain aspects of the material. However, results indicate that simply repeating a message, or adding new information in the time saved by the compression process, is not likely to increase the amount learned over that learned by listening to an unelaborated selection presented once at a normal (e.g., 175 words per minute) rate of speech.

(5) Reading materials can be scaled for listening difficulty by magnitude estimation, by a readability formula, by Cloze techniques, by recall tests, or by direct category scaling procedures. Correlations among these methods range from .85 to .95.

(6) The time compression/expansion technology can be used to "tailor" listening materials to fit fixed time slots. When coupled with the inexpensive and easy to transport cassette recorders that are currently available, this technology permits a flexible use of audio materials.

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Learning by Listening in Relation to Aptitude, Reading, and Rate-Controlled Speech: Additional Studies

INTRODUCTION

One of the concerns of the research under Work Unit REALISTIC is to explore methods for reducing training and job requirements for reading, with the idea of improving the military utilization of many lower aptitude men who are deficient in reading skills. The research reported here concerns the possibility of reducing the need for reading skills by substituting listening for reading.

Previous work in REALISTIC[1] evaluated the relative effectiveness of reading and listening as means for instructing men of different mental aptitude levels, as indicated by scores on the Armed Forces Qualification Test (AFQT). The results indicated that: (a) With average and low-aptitude men, listening was as effective as reading in promoting the recall of factual information from simple and complex passages; (b) reading and listening performance of the average aptitude group surpassed that of the low aptitude group; and (c) some individuals in both aptitude groups did better by reading than by listening and vice versa.

In Part I of the present report, additional data concerning reading and listening are presented. In this case, the factor of interest is preference for learning by listening versus learning by reading. Results of a survey of men of different reading ability levels are presented to explore possible motivating factors in the provision of listening materials in place of reading materials.

In Part II, experiments are reported that extend and add to the results of previous research (1) in which time-compression or expansion of magnetic tapes was used to vary the speech rate of listening materials, so that such materials might be presented at speech rates comparable to a silent reader's reading rate.

The experiments in Part II consider some technological problems in time compressing speech for instruction by listening, and the effects of speech rate upon the learning of materials of different levels of difficulty by men of high and low mental aptitude are examined. Attention is given to both how and how much the high and low aptitude men differ in their processing of information presented for learning by listening, and research to increase the amount learned in a given unit of time is reported.

Part III summarizes the experiments and provides a discussion of educational, training, and research implications of the present studies as well as of previous research in Work Unit REALISTIC, and the work of others concerned with learning by listening. Readers not concerned with the technical details of the individual studies might wish to turn directly to Part III.

[1] Thomas G. Sticht. *Learning by Listening in Relation to Aptitude, Reading, and Rate-Controlled Speech*, HumRRO Technical Report 69-23, December 1969 (1).

Part I

PREFERENCE FOR LEARNING BY LISTENING VERSUS READING

Two features to be considered when evaluating any educational innovation are its effectiveness in the transfer of information and its motivational properties. If two methods of presenting information are equally effective, then the decisions to use one method rather than, or in addition to, the other may be influenced by how well a method motivates the student to learn.

Earlier research (1) has indicated that both AFQT mental category IV and non-IV men[2] may learn meaningful prose materials just as well by listening as by reading. This was true for college level material as well as grade school material. Similar results have been reported by others who have compared learning by listening with learning by reading in adults.

While the earlier research indicated that meaningful prose information may be transferred equally well to adults by listening and by reading materials, the question of motivation still remains to be answered. Is it likely that low-aptitude men, with poor reading skills, may prefer to learn by listening rather than by reading, even though they may not learn any better? A survey was directed toward answering this question.

METHOD

MATERIALS

Information on relationships between reading ability and preference for learning by listening was gathered by means of a questionnaire[3] and a reading test. In addition to subject identification data, the questionnaire asked for information concerning age, education, training in reading in the Army, place of birth, use of English in the home, eye or ear trouble, and type of work desired on return to civilian life. Most pertinent to this survey was the question: "In learning a lesson, would you rather (a) *hear* it from a tape recorder or (b) *read* it from a book or paper."

To assess reading skills, the Survey of Reading Achievement, Junior High Level (grades 7-9), developed by the California Test Bureau, was used. This test was chosen because it was being used in additional work on REALISTIC to determine relationships between reading and job proficiency. It provides a composite index of reading skills expressed in school grade equivalents and provides this index for a wide span of abilities (grades 4.0-14.9).

[2] Armed Forces Qualification Test scores: Category I, 93-99; Category II, 65-92; Category III, 31-64; Category IV, 10-30.

[3] The questionnaire was administered for joint purposes of HumRRO Work Unit SPECTRUM and Work Unit REALISTIC. Thus, certain of the questionnaire data are not reported here.

SUBJECTS AND PROCEDURE

Men in five classes of Advanced Individual Training (AIT) were surveyed. The AIT courses surveyed included Field Wireman, Light Vehicle Driver, and Basic Administration. A total of 416 men were surveyed and tested for reading level.

The survey and testing were accomplished at the schools where the men were undergoing AIT. The questionnaire was answered and then the reading test was administered. The entire procedure lasted approximately one hour.

RESULTS AND DISCUSSION

The reading grade level scores were determined for each man and tallies of the preference for listening were made. These data for five reading grade level groupings are presented in Table 1. It is apparent that there is a relationship between reading ability and stated preference for learning by listening. Almost half of the men reading at the grade 4-6.9 level stated that they would prefer to learn from a tape rather than a book.

Table 1

Percentage of Men Who Preferred Learning by Listening Over Reading, by Reading Grade Level

Reading Grade Level	N	Prefer to Listen (%)
4-6.9	87	45
7-8.9	106	25
9-10.9	92	23
11-12.9	67	12
13+	49	14

In Table 2, the data have been grouped by mental category on the AFQT (mental category scores were not available for some men, hence the total N in Table 2 is less than in Table 1). This grouping shows a consistent, though not so extensive relationship between aptitude and preference for learning by listening. A comparison of Tables 1 and 2 shows that the preference for listening is more closely related to reading ability than to AFQT category. In both cases, however, it is men at the lower end of the scale who are more likely to prefer to learn by listening rather than reading.

As mentioned earlier, previous work in REALISTIC showed that men of high and low aptitude learned a wide range of prose material by listening as well as by reading. Thus, for certain materials either modality may be equally effective in transmitting information. However, the present data suggest that listening and reading materials may have different appeal for high and low aptitude men, and especially for poorer readers. The implication is that a significant segment of the military population might be induced to study if listening tapes were made available where there is material of meaningful prose quality to be taught.

The economic feasibility of providing a wide assortment of listening materials is enhanced by the availability today of relatively inexpensive, rugged cassette tape recorders or playback units. Lectures, military speeches, conversations, and so forth can be recorded on cassettes and be made available to interested students on an individual

Table 2

Percentage of Men Who Preferred Learning by Listening Over Reading, by AFQT Category

Mental Category	N	Prefer to Listen (%)
I (High)	13	8
II	74	19
III	150	27
IV (Low)	85	28

basis, thus permitting the slower learner to listen again to a lecture presented earlier. Conceivably, additional motivation might be gained by preparing tapes that incorporate music, perhaps in disc-jockey style, with information offered as "commercials."

In addition, tapes might be prepared that do not simply present a "talking voice," but use dramatic readings or exchanges among lecturers and students, or other devices to avoid the stultifying effects of a dull lecture presented in a monotonous manner. Additional ideas for the use of cassette recorders may be found in an article by McInnis (2).

The conclusion to be drawn from this survey and prior research is that men who read poorly may prefer to learn by listening rather than by reading, although they may learn equally well by either means. Part II of this report gives further consideration to factors influencing the learning of listening materials.

Part II

FACTORS INFLUENCING LEARNING BY LISTENING

Experiment I

SIGNAL DISTORTION VERSUS SPEECH RATE IN COMPREHENSION OF TIME-COMPRESSED SPEECH

As noted in previous REALISTIC research (1), a possible drawback to listening as an instructional process is that the listening rate is determined by the speaker's rate of speech. For low aptitude men, the message might be presented too fast, while for higher aptitude men faster rates of speech might be preferable.

Recent developments (3) have provided equipment that permits a wide range of variations in the speech rate of tape-recorded messages. The speech rate may be speeded-up or slowed down without producing the changes in the frequency spectrum that are heard, for example, when a 33 1/3 rpm recording is played at 78 rpm, or vice versa.

The electromechanical process for accelerating speech is analogous to cutting out and discarding small, periodic bits ("samples") of a tape, and splicing the remainder together to form a continuous tape. This process depends upon the fact that the duration of most speech elements, or phonemes, is greater than actually needed for perception of the speech sounds. Due to this temporal redundancy, a considerable portion (up to 75% in some cases) of a word may be deleted without totally impairing its intelligibility (3). Because the acceleration process reduces the amount of time required to present a message, the message is said to be time-compressed.

Time-expanded speech is produced by periodically repeating a small segment of a recorded message. This results in perceptual deceleration of the speech so that it sounds slower than the normal recorded speech.

Previously (3) it has been found that, when speech is accelerated by this sampling method beyond 250-300 words per minute (wpm), a significant loss in comprehensibility of the message usually occurs. This suggests that the rate of information presentation may exceed the ability of the listener to deal with it. However, since there is a certain amount of signal distortion of the speech signal due to the deletion of small segments of the speech wave form in the sampling method of time-compression, it is desirable to know whether the loss in comprehension at the faster speech rates is due to the rate of information presentation or to the signal degradation introduced by the compression process or, possibly, to interactions of these factors.

This problem was investigated earlier (4) using an approach which involved the preparation of three listening messages. One message was recorded at 0% compression (i.e., normal), a second was prepared at 40% compression, and a third was prepared at 40% compression and then expanded to restore the speech rate to normal. It was reasoned that if speech rate is more important than signal distortion in reducing comprehension, then restoring the speech rate of the compressed message to normal, through the expansion process, should result in comprehension test scores equal to those obtained with the uncompressed selection.

The results of the research indicated that restoring the speech rate of the compressed tape to normal by means of the expansion process did, indeed, return

comprehension to normal. It was concluded, therefore, that the rate of speech, and not the signal distortion, was the more important variable in influencing the reduction in comprehension at the faster rates of speech.

To confirm the foregoing, the present research extended the analyses to include the compression of speech by 20% (206 wpm), 40% (275 wpm), and 47% (300 wpm) with expansion to normal. In addition, two groups of subjects were used—high and low mental aptitude subjects (the research cited above involved only high aptitude subjects). Previous research (1) has indicated that the listening skills of low aptitude men differ considerably from those of high aptitude men. Therefore, it was desirable in the present study to determine whether the compression/expansion process would produce comparable results for both levels of aptitude.

METHOD

Subjects

The subjects were 280 Army inductees from Fort Ord, California. Half of the men had Armed Forces Qualification Test (AFQT) scores of 80 or above, (high aptitude) and half had AFQT scores of 30 or below (low aptitude). These mental aptitude test scores are not intelligence test scores. Rather, they indicate ability to benefit from military training and are the result of both heredity and educational experience. In terms of intelligence test scores, an AFQT score of 80 corresponds roughly to a Wechsler IQ of 110-115, while an AFQT score of 30 would correspond roughly to a Wechsler score of 80-90 (5).

The 140 men in each aptitude group were divided into seven subgroups, each containing 20 men. Each group listened to a different version of three recorded messages. Group 1 listened to the recordings presented uncompressed at a normal speech rate of 165 wpm. Groups 2, 3, and 4 listened to the same selections presented at compression ratios of 20% (206 wpm), 40% (275 wpm), and 47% (300 wpm). Groups 5, 6, and 7 listened to the same tapes as heard by Groups 2, 3, and 4 but in each case the compressed tapes were expanded to restore the speech rate to normal (165 wpm). Thus, Groups 5, 6, and 7 listened to tapes that were first compressed and then expanded.

Materials

Three listening selections were prepared, each based on some activity related to military service. The first selection concerned fire drill instructions, the second presented a combat situation, and the third described the transfer unit of a 2 1/2-ton truck. The time required to listen to each of the selections in uncompressed form was 55 seconds, 36 seconds, and 56 seconds respectively.

The listening selections were subjected to compression and compression/expansion to produce the seven versions described above. Compression and expansion were accomplished by means of the Eltro Information Rate Changer.[4]

Procedure

The seven groups of subjects were tested on different days in an ordinary classroom. High and low aptitude subjects were tested at the same session. The subjects were seated in a semi-circle near a tape recorder. They were told that they were going to be tested to determine how well they could remember listening selections. They would hear three

[4]**Identification of products is for research documentation purposes only; this listing does not constitute an official endorsement by either HumRRO or the Department of the Army.**

selections; following each, they would be asked questions about the selection and would write their answers on the answer sheets provided. Questions from the subjects were answered, and the tests were then administered.

For each selection, the comprehension test included 12 "fill-in-the-blank" questions about factual information in the selection. The questions were read aloud and repeated as often as requested by the subjects. The same procedure was followed for the uncompressed, compressed, and compressed/expanded versions of the listening selections. All materials were presented at a "comfortable" listening level established by the subjects.

RESULTS AND DISCUSSION

The means and standard deviations of the comprehension scores in terms of the number of questions correctly answered are presented in Table 3. The scores are summed for all three listening selections, so the maximum score possible is 36 correct. Table 3 also presents biographical data for the various groups.

Figure 1 presents the data from Table 3 in graphic form, and transformed into percent correct scores. Analysis of variance was performed for the three pairs of groups who listened to compressed and compressed/expanded messages (thus the unpaired, uncompressed conditions were omitted from the analysis). Table 4 summarizes the analysis of variance. In this analysis, the B factor, compression ratio, refers to the three levels of compression (20%, 40%, 47%) used to prepare both compressed and compressed/expanded materials. The C factor, speech rate, refers to the compressed materials, in

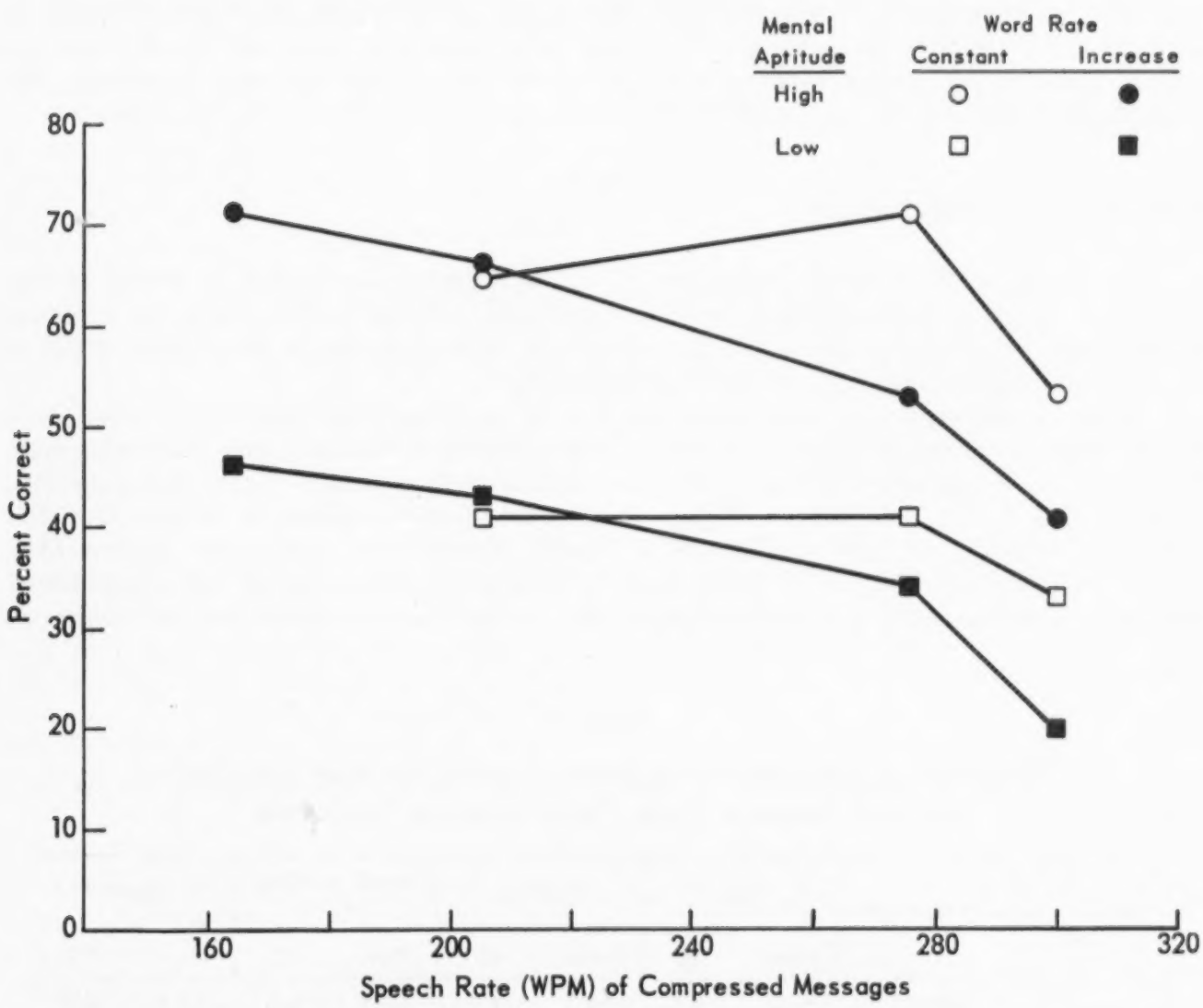
Table 3

Biographical Data and Comprehension Scores for High and Low Aptitude Subjects Under Three Listening Conditions

Aptitude Group	Compression Ratio[a]	Age		Education		Mental Aptitude (AFQT)		Score	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
High	0C	21.4	2.1	14.7	1.9	88.1	5.5	25.9	4.9
Low	0C	18.0	1.3	11.2	1.0	22.0	5.8	16.8	4.3
High	20C	22.0	2.5	14.1	2.0	90.2	5.5	24.1	4.7
Low	20C	20.0	2.4	10.9	1.3	20.8	5.7	15.7	2.9
High	20C/E	20.5	2.4	13.7	2.4	88.6	5.3	23.9	3.3
Low	20C/E	17.9	1.6	10.7	1.0	24.0	5.4	14.8	5.0
High	40C	21.2	1.7	13.8	2.0	90.3	3.9	19.5	4.2
Low	40C	18.7	1.9	10.7	1.4	21.4	5.2	12.7	4.4
High	40C/E	21.0	2.6	14.1	2.4	89.3	6.0	26.1	3.4
Low	40C/E	18.8	1.8	10.6	1.2	23.8	4.2	14.8	4.5
High	47C	20.6	1.1	13.6	1.7	87.2	5.8	15.1	4.1
Low	47C	19.7	1.1	11.2	1.4	22.4	5.5	7.7	2.8
High	47C/E	21.5	1.9	14.6	2.0	90.8	6.1	19.5	3.9
Low	47C/E	19.7	3.8	11.5	1.2	22.1	6.0	12.2	4.0

[a]0C = 0% Compression (Normal); 20C = 20% Compression; 20C/E = 20% Compression/Expansion.

Scores for High and Low Aptitude Subjects on Speech Increased by Time-Compression or Maintained at Constant Speed by Time-Compression/Expansion



NOTE: Filled symbols = Tape recorded speech increased in speed by time compression.
Open symbols = Tape recorded speech maintained at constant speed by time compression and then expansion.

Figure 1

which the speech rate was increased, and the compressed/expanded materials in which the speech rate was constant at 165 wpm.

The significant interaction of compression ratio and speech rate (BC) is indicated in Figure 1 by the divergence of the curves for which the speech rate was constant from the curves for which speech rate was increased. Tests of the simple effects of increased vs. constant speech rate at each of the three compression levels indicated no significant differences between the 20% compressed (206 wpm) condition and the 20% compressed/expanded (165 wpm) condition. The remaining two pairs differed significantly ($p<.001$). A separate analysis of variance was performed on the data for the two aptitude groups for the uncompressed, 20% compressed, and 20% compressed/expanded conditions and indicated no significant differences due to those conditions (aptitude was significant, $p<.001$).

Table 4

Analysis of Variance: Comprehension of Compressed vs. Compressed/Expanded Materials

Source	*df*	*MS*	*F*	*P*
Aptitude (A)	1	4,191.70	263.96	<.001
Compression Ratio (B)	2	797.26	50.21	<.001
Speech Rate (C)	1	456.50	28.75	<.001
AB	2	15.64	<1	NS
AC	1	42.51	2.68	NS
BC	2	161.76	10.19	<.005
ABC	2	30.45	1.92	NS
Within Cell	228	15.88		
Total	239			

These data indicate that, using the present equipment, expanding previously compressed materials to restore the word rate to normal may restore the comprehension of the material to very near normal—when the compression/expansion is limited to 40%. When the materials are compressed/expansion is limited to 40%. When the materials are compressed/expanded by 47%, there is apparently enough noise and/or signal distortion added to reduce comprehensibility of the material significantly below normal, although the restoration of a normal word rate appears to improve the comprehensibility of the material to a limited degree. These effects appear to hold for both high and low aptitude men.

As mentioned earlier, it was previously found (4) that, with high aptitude subjects similar to those of the present study, expanding selections previously compressed by 40% to return speech rate (275 wpm) to normal (165 wpm) restored the comprehension of the material to normal. It was concluded that the reduction in comprehension with the compressed material was therefore due to the speech rate, and not the signal distortion produced by the compression process. This conclusion followed from the fact that, although the expansion process added additional signal distortion to the compressed tapes, it restored the speech rate to normal, and comprehension also returned to normal. Thus, while signal distortion was common to both the compressed and compressed/expanded tapes, the former presented materials at an accelerated speech rate, while the latter presented messages at a "normal" rate, and the comprehension improved.

These findings led to the conclusion that the factors limiting the comprehensibility of rapid speech resided more with the inability of the listener to process rapid rates of speech than with the signal distortion produced by the equipment (or compression process). The present results substantiate the previous findings and conclusions for materials compressed up to 40%. However, when materials are compressed 47% and then expanded to restore the word rate to normal, there appears to be a significant amount of signal distortion to prevent the restoration of comprehension to normal.

Because the compressed/expanded materials contain distortions and noise due to both compression and expansion, it is not clear to what extent the signal degradation accompanying the higher rates of compression may interact with the speech acceleration factor to produce the generally observed decrements in comprehension. However, an estimate of the degree to which the signal distortion factor may influence comprehension may be obtained by comparing the comprehensibility of materials which have been compressed by 47% with the same materials subjected to equal or greater amounts of expansion.

The compression process produces distortion by periodically deleting a brief segment of the recorded speech and joining together the remaining signal segments. This brings together speech segments whose boundaries do not match exactly. In the expansion process, signal distortion is introduced by periodically repeating small segments of the speech stream. Again, this brings together speech segments with unmatched boundaries.

If the frequency of repetition in the expansion process is equal to or greater than the frequency of deletion in the compression process, similar or greater amounts of signal distortion in the form of segmental boundaries will be introduced into the expanded message as is produced in the compressed message. However, the expansion process produces a decrease in speech rate while the compression process produces an increase in the speech rate. Thus, by comparing the comprehensibility of materials expanded or compressed to produce similar frequencies of reproduction or deletion, the effects of signal distortion with and without rapid speech rates can be explored.

Table 5 shows a subset of data from Experiment 3, reported later, which compares the comprehensibility of 150-word, fifth-grade reading selections expanded or compressed by three different amounts. The material compressed by 58% contains more signal distortion due to repetition boundaries, and the 16% expanded materials less such distortion than was produced by the periodic deletion of speech segments in the materials compressed by 47%. Each mean is the average comprehension test score of a group of 17 High (AFQT $\geq$80) or Low (AFQT $\leq$30) aptitude Army inductees.

The data of Table 5 indicate that, although there was more distortion in the material expanded by 58% than in the 47% compressed materials, the latter was less comprehensible than the former. This appears to be true for both high and low aptitude men (as evaluated by *t* tests, the compressed materials differed significantly from the expanded materials, while the expanded materials were not significantly different, $p<.05$). These findings suggest that at even the higher levels of compression, the speech rate factor is a more potent determiner of the comprehensibility of materials than is the signal distortion.

The foregoing conclusion is further suggested by the work of Fairbanks, Guttman, and Miron (6), who showed that compressing materials by as much as 50% on their sampling equipment produced very little loss in comprehension. In their case, the uncompressed speech rate was 141 wpm and the 50% compressed rate was 282 wpm—a rate found by many to affect comprehension only slightly

Table 5

Comprehension Scores of High and Low Aptitude Subjects Listening to Time-Expanded or Compressed Speech

(percent)

Test Material	High Aptitude		Low Aptitude	
	Mean	SD	Mean	SD
Expanded				
58% - 125 wpm	80.1	2.9	58.0	11.5
16% - 175 wpm	82.6	3.0	55.0	12.2
Compressed				
47% - 375 wpm	69.6	4.2	41.2	11.0

For the data of Table 3, 47% compression of a message originally recorded at 200 wpm produced a word rate of 375 wpm. Although Fairbanks *et al.* introduced a greater number of segment boundaries (with their materials compressed by 50%), the resulting speech rate did not reduce comprehension to any notable degree.

It appears, then, that previous conclusions still hold, ". . . the barrier to the comprehension of fast rates of speech appears to be within the information processing capacities of the listener, and not in the fidelity of the time-compressed signal. In short, the problem is primarily due to human, not equipment, shortcomings." (4) In Experiments 3 and 4, research focuses upon these information processing capabilities of high and low aptitude men using listening materials of differing difficulty levels and speech rates. First, however, attention is given in Experiment 2 to the problem of assessing the difficulty level of materials.

EXPERIMENT 2

READING DIFFICULTY OF PRINTED TEXT EVALUATED BY THREE DIFFERENT METHODS

To determine the interacting effects of speech rate and difficulty of materials upon learning by listening, it is necessary to obtain materials that have been scaled for difficulty. In the present research, a method of direct magnitude estimation and a readability formula derived by Farr, Jenkins, and Paterson (7) were used to scale a set of 34 150-word passages prepared by Miller and Coleman (8) for difficulty of understanding and comprehension.

These passages were from a set of 36 150-word passages which had been scaled for complexity using, among others, bilateral Cloze procedures in which every fifth word in the reading passage is deleted and the subjects are asked to fill in the missing words as they read the passage. Easy passages were considered to be those in which the greatest number of correct responses was obtained.

In subsequent research on the Miller-Coleman passages (MCP), Aquino (9) confirmed that the passages were, indeed, scaled from least to most difficult. He did this in two ways. In one method, the subjects read the passages and attempted to recall them word-for-word immediately after reading them. In a second method, the subjects sorted the passages in a category scaling procedure, ranking them from one to 36, by sub-sorting routines, in terms of the difficulty of the passages. The word-for-word recall and judged difficulty procedures correlated .91 and .92, respectively, with the difficulty scale formed by bilateral Cloze procedures with the MCP.

The present research, like that of Aquino, is concerned with the validation of the MCP as a scale of difficulty. Whereas Aquino used recall scores and category scaling procedures to scale the MCP, the present research used readability scores and direct magnitude estimation of subjective difficulty. In addition, oral reading times were obtained for each passage. These data have been analyzed in such a way as to suggest a mechanism for the judgments of difficulty.

METHOD

Subjects

The subjects were 10 male staff members of the research division. Nine were 20 to 27 years old, and one was 36. All subjects had college degrees, and may be considered as high in verbal ability.

Materials

Copies were obtained of the 34 Miller-Coleman passages (MCP) deposited with the American Documentation Institute. The passages were numbered one through 34 in the same order in which they were received from the Documentation Center. This ranks the materials from easiest to most difficult. The bilateral constraint Cloze score for the easiest passage was 78.2% correct; for the most difficult passage the score was 22.7%.

From these passages, selection 19 was chosen as the standard stimulus in a task involving the direct magnitude estimation of difficulty. Selection 19 has a bilateral Cloze score of 53.2, roughly midway along the complexity continuum of Miller and Coleman. The remaining 33 passages were sorted into three groups of eleven each by means of a table of random numbers. The standard was added to each group, making 12 passages per group.

Procedure

On three consecutive days, the subjects individually read aloud the 12 passages in one of the three groups. The subjects were first asked to read the standard stimulus and were instructed to assign it a difficulty level of 10, representing how difficult the passage was to read for understanding and comprehension. They were then told to read aloud each of the remaining passages, and then, immediately after reading each passage, to judge it in terms of difficulty of comprehension. If they thought the passage was twice as difficult as the standard, they should assign it a rating of 20; if they thought it was half as difficult, they should give it a rating of five, and so on.

All the subjects indicated that they understood the procedure before the scaling began. Each day the standard was the same, and was read prior to the scaling of the materials. Thus, all 33 passages were scaled relative to the same standard. Reading times were measured for each subject and each passage by means of a stopwatch.

To obtain data on the readability of the passages, the readability formula of Farr, Jenkins, and Paterson (7) was used. The number of monosyllabic words and the average number of words per sentence were computed for the first 100 words of each passage. These figures were used in computing the grade school level of readability of each passage.

RESULTS AND DISCUSSION

For each passage, the median of the magnitude estimations by the 10 subjects was obtained. Correlation coefficients were computed between the median magnitude estimation scores, the bilateral Cloze scores, the Flesch readability scores, and the difficulty scores obtained with category scaling by Aquino (9). The Pearson *r*'s are given in Table 6. The *r*'s obtained in the present work are somewhat smaller than those reported by Aquino, yet the uniformly high correlations among the various scales of difficulty seem to validate the MCP as a scale of readability (difficulty). This agrees with the findings of Aquino and of Carver[5], although the latter takes a somewhat idiosyncratic and limited definition of the term "readability" and concludes that the MCP form a scale of *difficulty* but not a scale of *readability*. His usage of the term is clearly a restricted one in view of the three usages of the term "readability" provided by Klare (10) in his comprehensive review.

[5] R.P. Carver. "Evidence for the Invalidity of the Miller-Coleman Readability Scale," manuscript in preparation, 1970.

Table 6

Correlations Between Measures of Difficulty of Miller-Coleman Passages

	Readability Formula	Judged Difficulty/CS[a]	Judged Difficulty/ME[b]
Bilateral Cloze[c]	-.85	-.93	-.86
Readability Formula	—	.84	.82
Judged Difficulty/CS		—	.82

[a]CS = Category Scale, Aquino (9)
[b]ME = Magnitude Estimation
[c]In contrast to other measures, Cloze scores are scaled from low (difficult) to high (easy), resulting in minus signs for the correlation.

Of additional concern in the present work was the relationship between the oral reading rate and the estimated difficulty of the passages. Two measures of reading rate were determined, the syllables per minute (spm) rate and the words per minute (wpm) rate. These two measures reflect different attributes of the MCP, because while all passages contain 150 words, the number of syllables increases from nearly 180 with the most simple materials, to more than 300 syllables in the most difficult materials.

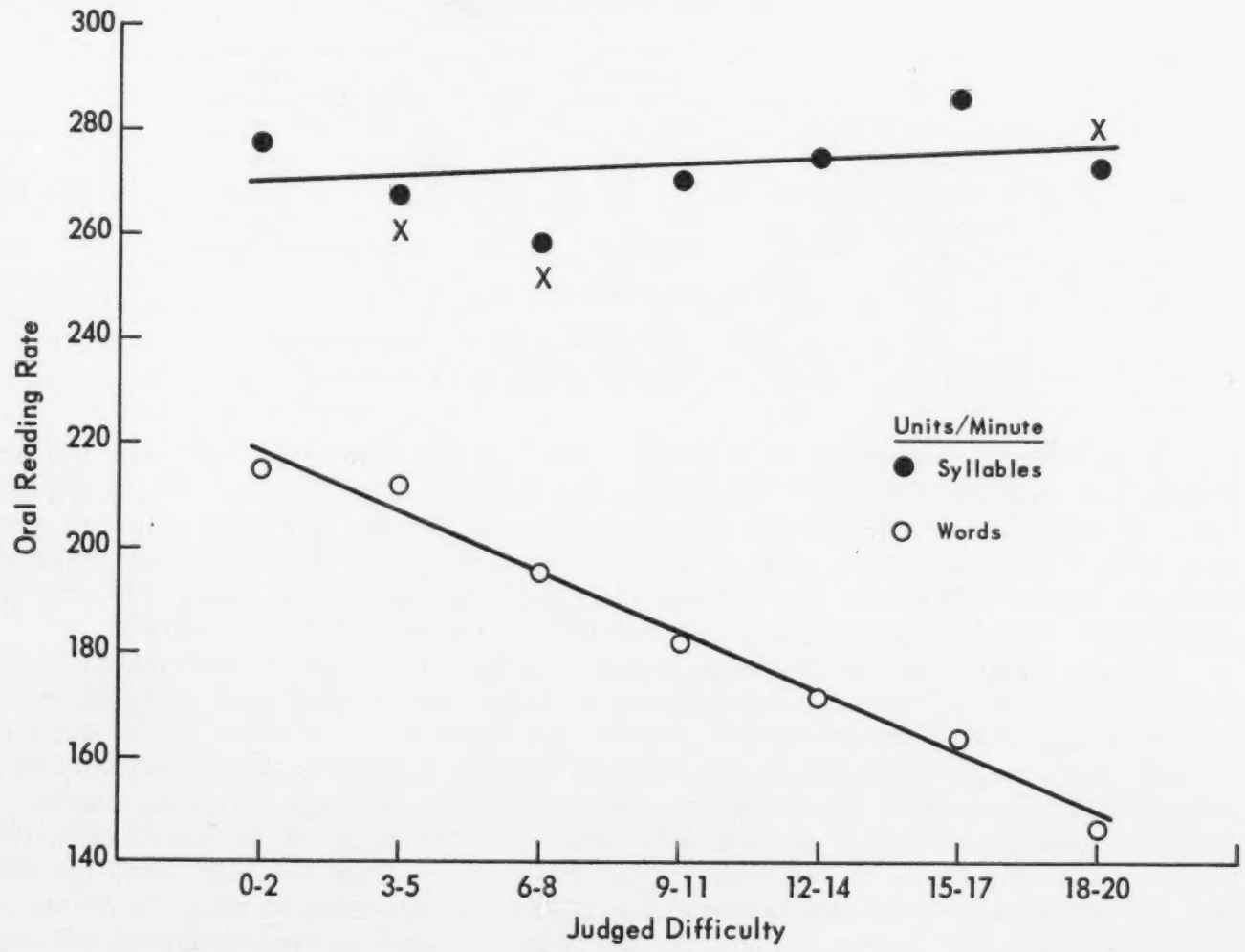
Figure 2 shows the relationships between judged difficulty, as determined in the present study by direct magnitude estimation, and oral reading rate in syllables per minute (upper curve) and words per minute. The Pearson *r*'s for these relationships are .20 and —.85, respectively. These data indicate that the changes in judged difficulty were accompanied by a linear decrement in wpm rate, while the spm rate was maintained (perhaps slightly increasing) at near 270 spm over the range of estimated difficulty. Similar results are found in the work by Carver, who also used the MCP, when his wpm data are averaged over his two experimental graphs and converted to spm. His results are presented as the "X" points in Figure 2. The correspondence is remarkable and reflects a very stable reading rate for these passages, whether reading aloud, as in the present work, or silently, as in Carver's work.

While it is not possible on the basis of the present data to completely determine the processes by which the judgments of difficulty were made, it is possible to rule out certain factors and suggest others. We can consider at least three aspects of the task: (a) the decoding problem, that is, converting graphemes to morphemes; (b) the information-processing activities involved in comprehending the materials; (c) the encoding problem involved in reading the messages aloud.

Because the same general results have been obtained using silent (9) and oral reading, the encoding activities seem unlikely candidates for a standard against which judgments of difficulty were made.

With regard to the information-processing activities, the work of Carver presents evidence to suggest that the internal processing activities may have played little or no role in the judgments of difficulty. He required the subjects to read four of the MCP which ranged from easy to difficult. The subjects in one group were tested after each passage and their papers were scored in their presence, thus providing feedback on their performance. A second group was tested without feedback. The results showed that, although the groups learned equally well, the group with feedback reduced their reading rates, but not as a function of the difficulty of the passages. Rather, their speech rate reduction was uniform across all passages. Furthermore, as indicated in Figure 2 by the X points, when speech rate was stated in terms of spm, there was no decrease in speech rate as a

Oral Reading Rate as a Function of Estimated Magnitude of Reading Difficulty of Printed Texts



NOTE: X = Similar results by Carver.

Figure 2

function of judged difficulty. Apparently then, the only effect of the feedback was to generally retard the reading rate of the subjects in the group.

It seems reasonable to assume that the feedback group was performing different internal information-processing activities, and yet this difference was not reflected by differential speech rate data for the passages of different difficulty levels. This being so, it seems unlikely that judgments of difficulty of the MCP rely to any great extent upon changes in information-processing activities. At least such changes did not result in feedback X difficulty interaction effects on reading rate in Carver's data.

If the encoding and information-processing activities are ruled out as the basis for making judgments of difficulty, the burden falls in the decoding required in converting from visual to verbal symbolism. One aspect of the decoding task is the decoding of the graphemes to morphemes, another is the synthesis of meaning from these morphemes (cf. 11 for a discussion of the analysis-by-synthesis model of speech perception), which for present purposes, we will call decoding to meaning.

The probability that the difficulty judgments reflected increased difficulty in decoding to meaning seems unlikely in view of the fact that the rate of decoding, indicated by the spm, remained the same over the range of materials. This is not to

suggest that the difficulty level of the meaning of the materials does not vary—results of Cloze tests have shown that they do. Rather, it suggests that this change in meaningfulness may have been ignored by the subjects in making their judgments.

The upshot of this analysis is the hypothesis that the judgments of difficulty observed in this research, and perhaps the work of Aquino (9), were based primarily upon the amount of grapheme to morpheme decoding required. This hypothesis is supported by the fact that the correlation between the number of syllables in the passages and judged difficulty was .87. Thus, the subjects may simply have estimated difficulty on the basis of the number of syllables produced, or on the amount of time required to read the passage, which increased in direct proportion to the number of syllables in the passages and correlated .86 with judged difficulty.

Regardless of the mechanism for judging the complexity of the Miller-Coleman passages, they apparently represent a continuum of complexity (8) and reading difficulty (9) when evaluated by Cloze tests, a readability formula, recall tests (9), category scaling (9), and direct magnitude estimations. This testifies to the validity of the various methods for scaling the reading difficulty of printed materials, and confirms the usefulness of these passages for a variety of problems in verbal learning. One such problem is described in the next experiment.

EXPERIMENT 3

EFFECTS OF SPEECH RATE, SELECTION DIFFICULTY, AND MENTAL APTITUDE ON LEARNING BY LISTENING

Elsewhere (1) it was found that men of high and low mental aptitude suffered a decrease in comprehension of a listening selection when the speech rate was increased from 175 to 425 wpm. Experiment 3 extends the previous observations to evaluate the combined effects of the difficulty level of the listening materials, the speech rate of presentation, and mental aptitude on the comprehension of the listening selection.

METHOD

Subjects

The subjects were 204 Army inductees, half of whom were men with AFQT scores at the 30th percentile or below (low mental aptitude, LMA), while the other half were men with AFQT scores at the 80th percentile or above (high mental aptitude, HMA). The subjects were assigned to the experimental conditions in an unsystematic manner as they became available until an N of 17 per condition was obtained. Within an aptitude category, subjects across all conditions were comparable with regard to education, AFQT, and age. All the subjects were Caucasians.

Materials

The materials used were selections 7 and 15 (low difficulty), 23 and 31 (medium difficulty), and 26 and 30 (high difficulty) from the 34 passages scaled for difficulty in Experiment 2 (8).

For this experiment, the six passages were grouped as indicated into three levels of difficulty—low, medium, and high. The readability scores, in school grade equivalents, for the six passages were: 6.0 and 5.0, 8.5 and 8.5, and 14.5 and 14.5. The estimated

magnitude of difficulty scores were: 4.5 and 4.5, 8.0 and 8.0, and 12.0 and 11.5. The Cloze test scores were: 67.2 and 63.0, 47.8 and 46.2, and 35.0 and 33.0. Thus, by all three indices, the materials were of low, medium, and high difficulty.

The passages were prepared for this experiment by having them recorded in the order given above on magnetic tape at 200 wpm. Then, using the Eltro Information Rate Changer, the tapes were expanded by 58, 34, and 16% to produce speech rates of 125, 150, and 175 wpm. Two additional versions were prepared by compression at 43 and 47% to produce speech rates of 350 and 375 wpm.

For each passage, a Cloze test was formed by deleting every fith word and substituting a standard six-stroke line. Since each passage was 150 words long, deleting every fifth word produced a comprehension test of 30 items per passage (an oversight reduced this to 29 items for the first passage in the low difficulty groups). The Cloze tests were grouped into booklets, and separate answer sheets were provided on which the students could write their responses.

Procedure

The subjects were tested in two sound-deadened testing rooms. Each room contained 10 listening cubicles, each provided with earphones and gain control so that each subject could adjust the selections to a comfortable listening level to suit himself. Prior to listening to the experimental selections, the subjects listened to a warm-up passage of approximately one minute duration.

After the warm-up passage, the stimulus passages were presented, with the order of presentation always being the same—the easy passages were presented first, then the medium, and finally the most difficult passages. After each selection, the corresponding Cloze test was administered. The Cloze tests were scored by counting as correct only those items for which the response was the exact word that had been deleted. Misspellings were counted as correct. Synonyms were not counted as correct. The entire listening and testing procedure lasted one hour.

The subjects in both aptitude categories served in one of six conditions: baseline groups, in which the subjects took the tests without listening to the passages, and five experimental groups, who listened to the speech materials presented at either 125, 150, 175, 325, or 350 wpm and then took the tests.

RESULTS

For all treatment groups, the number correct scores for the two easy selections were combined, as were the scores for the two moderately difficult, and two difficult passages. The means and standard deviations were computed for each treatment group and are given in Table 7. These mean scores were converted to percent correct scores for presentation in Figure 3. In this figure, the dotted lines mark the baseline scores on the ordinate.

Results of the analysis of variance on the number correct scores for the five experimental treatments are given in Table 8. In view of the significant triple interaction of aptitude, speech rate, and message difficulty level, additional analyses were performed on the data for the HMA and LMA groups. These analyses indicated that, for HMA subjects, there was no significant materials X speech rate interaction, while for the LMA subjects this interaction was significant.

Examination of Figure 3 and the results of the analyses of variance indicate that the HMA subjects gained about as much when listening to the more difficult materials as when

listening to the easier materials, and this was apparently true for each rate of speech. On the other hand, the easier the materials and the slower the speech rate, the more LMA subjects appear to have learned.

Table 7

Scores for High/Low Aptitude Subjects on Speech Rate-Controlled Listening Tests of Three Levels of Difficulty

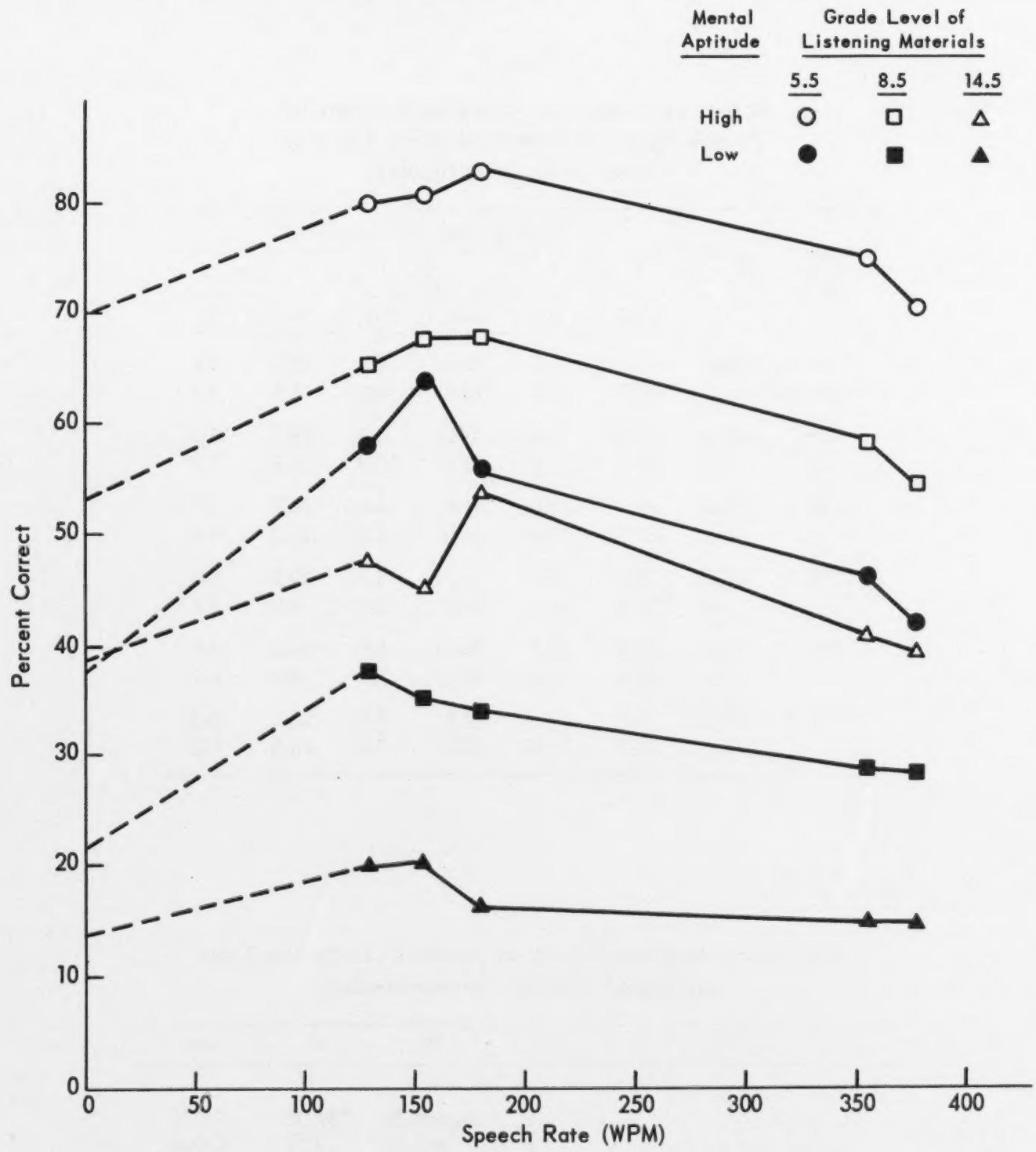
Speech Rate (wpm)	Mental Aptitude Group	Reading Grade Level of Material					
		5.5		8.5		14.5	
		Mean	SD	Mean	SD	Mean	SD
0 (baseline)	High	41.3	4.5	32.1	4.5	23.5	6.5
	Low	22.3	10.4	13.0	6.8	8.5	4.1
125	High	47.2	2.9	38.9	4.2	28.7	6.5
	Low	34.2	11.5	22.2	10.3	11.8	7.4
150	High	47.6	4.0	41.1	4.4	26.7	7.3
	Low	37.7	7.9	21.3	9.5	12.7	6.4
175	High	48.7	3.0	40.8	4.2	32.4	5.0
	Low	32.6	12.2	20.3	10.8	9.8	7.0
350	High	44.3	6.4	35.4	5.5	24.9	4.8
	Low	27.4	7.9	17.2	8.4	9.0	5.1
375	High	41.1	4.3	32.2	5.5	23.7	6.3
	Low	24.3	11.0	16.9	7.9	24.6	5.0

Table 8

Analysis of Variance: Effects of Aptitude, Difficulty Level, and Speech Rate on Comprehension

Source	*df*	*MS*	*F*	*P*
Between Subjects				
Aptitude (A)	1	34,555.30	287.39	<.005
Speech Rate (B)	4	925.95	7.71	<.005
AB	4	103.80	<1	NS
Error	160	120.24		
Within Subjects				
Difficulty (C)	2	16,366.41	922.57	<.005
AC	2	136.81	7.71	<.005
BC	8	50.24	2.83	<.005
ABC	8	56.88	3.21	<.005
Error	320	17.74		

Recall Scores for High and Low Aptitude Subjects for Materials of Three Difficulty Levels at Five Speech Rates



NOTE: The dotted lines mark baseline scores on the ordinate.

Figure 3

DISCUSSION

The present results differ from those of Fairbanks, Guttman, and Miron (6) working with Air Force personnel. They found no triple interaction of aptitude, speech rate, and message difficulty. However, as they pointed out, their aptitude range was fairly limited (stanines 5 to 8). Also, they defined message difficulty in a *post hoc* manner by studying the item difficulty of their test and reasoning that the more difficult items corresponded to more difficult material. This, of course, totally confounds test item difficulty and message content difficulty.

In the present research, message difficulty was determined before the research by three different scaling methods—Cloze tests, a readability formula, and direct magnitude estimations. Hence, it is clear that the messages were of differing difficulty. Also, the range of message difficulty may actually have been greater in the present work. This seems likely in view of the fact that the material used by Fairbanks *et al.* was a technical passage on meteorology, and they presented no materials comparable to the simple fifth or eighth grade material of this research.

A feature of note in the present data is the indication that the HMA subjects may have performed better at 175 wpm than at 150 or 125 wpm. Indeed, additional analyses of variance indicated a significant quadratic component for the HMA subjects (combining the three levels of material difficulty). This suggests an optimal speech rate for learning, and, in comparison with the curves for the LMA subjects in Figure 3, this speech rate may be somewhat faster for the HMA than for the LMA subjects.

While the foregoing suggests that replication would be useful, the notion that HMA subjects may learn materials presented at a faster rate than LMA subjects is not new. For example, in recent research, Shuell and Keppel (12) have utilized a differential in presentation rate of information to equate learning in HMA and LMA subjects. They found that HMA subjects learned a list of 30 words presented at a rate of 60 wpm as well as LMA subjects learned the list when presented at 12 wpm.

In work using accelerated speech (1), it has also been found that at certain rapid rates of speech HMA subjects learn about as much of a listening selection as do LMA subjects listening at normal rates of speech. Thus, as in the Shuell and Keppel paradigm, the use of the speech compression technique permits the arrangement of conditions so that HMA and LMA subjects learn the same amount from a listening selection. When this is done, of course, what is produced is a loss of comprehension for the HMA subjects from what they learn at normal rates of speech.

It has been hypothesized (3) and supported (4) that the reduction in comprehension with fast rates of speech occurs because the listener is unable to process information at a rapid rate for storage and subsequent retrieval from memory. This raises the question as to what is lost at the faster rates of speech. Are portions of the passage which demand more processing sacrificed and effort focused more on the easier to process segments? Or do subjects busy themselves with one segment and miss the next regardless of its demand for processing? Various strategies such as these (filtering and omission) have been identified (13) as ways for dealing with overloaded information channels.

Experiment 4 was an attempt to determine what kind of information is lost under conditions of rapid speech. The purpose was twofold: (a) to determine what kind of information is lost at faster rates of speech by HMA and LMA subjects, and (b) to learn how the HMA and LMA subjects differ in regard to their processing of information obtained by listening. LMA subjects do not learn as much as HMA subjects when listening at various rates of speech. Is this because they process information in a different, less effective way than HMA men, or do they process information in the same way, but just less of it?

EXPERIMENT 4

EFFECTS OF SPEECH RATE AND MENTAL APTITUDE ON PROCESSING INFORMATION IN LISTENING MATERIALS[6]

As a first effort in exploring the effects of speech rate and aptitude level on information processing of listening materials, an approach suggested by the work of Rosenberg (14) was used. His research has indicated that association strength between words affects how well they are learned in a prose selection. Word pairs of high association strength tend to be recalled as pairs, while word pairs of low association strength are learned as separate items. It is as though the high association pairs are learned in "chunks" (15) rather than as separate items of information.

Another way of viewing the learning of high and low association word pairs is to consider that the high association pairs are "easy" materials, while the low association pairs are "difficult" materials.

In Experiment 3 it was found that, across speech rates, the HMA subjects learned easy and difficult materials about equally well. The LMA subjects, on the other hand, learned the easier materials best at the "normal" range of speech rates, while they barely learned the difficult materials at all.

Viewed from this perspective, Experiment 4 is a partial replication of Experiment 3. What we have done is to construct materials having easy-to-learn, high-association word pairs, and difficult-to-learn, low-association word pairs. We then present these to HMA and LMA subjects and examine the results of recall tests to suggest how the high and low association materials are dealt with by the two aptitude groups for different speech rate conditions.

METHOD

Subjects

One hundred thirty-eight Caucasian Army inductees served as subjects. Seventy-two subjects had AFQT scores of 80 or above and formed a high mental aptitude (HMA) group. The remaining 66 subjects had AFQT scores of 30 or below and formed a low mental aptitude (LMA) group. Both HMA and LMA groups were trichotomized into three subgroups, each containing 24 and 22 men within the respective aptitude levels.

Materials

A 350-word listening passage was prepared which contained triplets of nouns embedded within sentences of the connected discourse. Within each triplet of words, there was a stimulus word (S-word) and two response words (R_1 and R_2) that varied according to their interword normative association strengths and proximity to the S-word. R_1 was a high-association response (HAR) to the S-word while R_2 was a low-association response (LAR) to the S-word. The association strengths were obtained from the new Minnesota Norms of Palermo and Jenkins (16).

Within the context of the passage, the S-word, HAR, and LAR always occurred in the same sentence for a given word triplet with the S-word preceding both the HAR and LAR responses and the HAR response preceding the LAR response. Thus, the LAR responses were "difficult" materials on the basis of both association and temporal proximity to the S-word.

The response words were grammatically appropriate in the context of the discourse and each pair was of the same form-class. As a concrete example of the materials, one

[6]Data for Experiment 4 were collected and analyzed by Dr. Douglas Glasnapp while he served as a pre-doctoral intern at HumRRO Division No. 3 from the George Peabody College for Teachers, 1969-70.

sentence was: "Inside, the room smelled of *tobacco*, *smoke*, and *oil*." In this sentence, *tobacco* is the S-word, *smoke* the HAR, and *oil* the LAR. A total of 18 such word triplets were embedded in sentences throughout the passage. The grade level of difficulty of the passage was 7.0, as determined by the method of Farr, Jenkins, and Paterson (7).

The passage was originally recorded at a speed of 200 words per minute (wpm). It then was expanded 19% and compressed 38% to give two passages, one at a normal listening rate of 170 wpm and the other at 325 wpm, respectively.

To test for recall of HAR and LAR responses, a Cloze test was administered. In the Cloze test the response words were deleted from the passage and subjects were instructed to fill in the blanks with the correct words. HAR and LAR responses were counted as correct if they occurred in *either* of the two response blanks corresponding to the correct S-word.

Procedure

One of the three groups from each aptitude level served as a control group. These two groups were administered the Cloze test without listening to any material. They were instructed to fill in the blank with a word they thought might fit. The group responses under this condition served as baseline data.

The other two groups within an aptitude level were administered the learning passage under one of two listening conditions, at a normal rate of speech (170 wpm) or at the accelerated rate (325 wpm). The subjects were told that they would hear a listening selection and that they were to try to learn as much of the passage as possible, as they would be tested when the passage was over. Under the compressed speech condition, the subjects first listened to a brief warmup passage to permit them to adjust to listening to a fast rate of speech. Following this, they listened to the experimental passage. Immediately after hearing the test passage, the subjects completed the Cloze test.

Mixed aptitude levels were tested during the same session in groups of approximately 30 men per day. The subjects were tested in a classroom and were seated at the front of the room with the tape recorder used to present the listening passage facing them. The volume on the tape recorder was adjusted until all men indicated they could hear it comfortably.

RESULTS

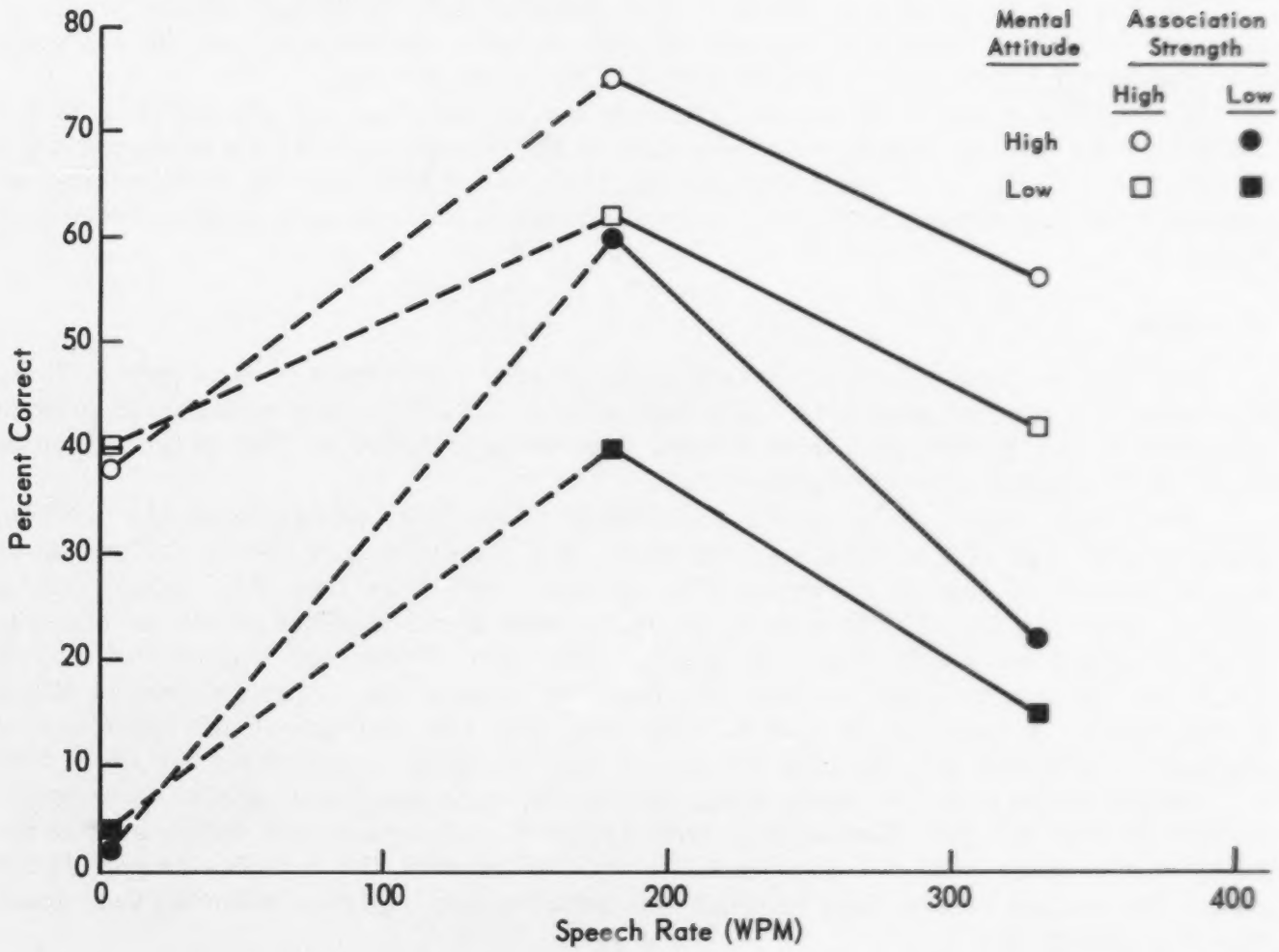
Means and standard deviations for the number of HAR and LAR responses obtained under each of the speech rate conditions and for each aptitude group are given in Table 9. The total number of correct responses possible under each condition was 18. Of note in Table 9 are the nearly identical baseline scores of the two aptitude groups for both HAR and LAR pairs. Evidently the listening materials were constructed so that the superior verbal ability of the HMA groups did not facilitate guessing of correct responses. Of the total number of responses guessed correctly on the baseline tests, 92% were HAR responses.

Figure 4 presents mean scores transformed to percent correct scores. A summary of the analyses of variance for the aptitude by association level by speech rate design is presented in Table 10. As indicated, one significant first order interaction was obtained.

In combination with Figure 4, the significant speech rate by association level interaction indicates that under compressed speech conditions, the mean number of correct LAR responses decreased to a greater extent than HAR responses.

Also, it is clear from Figure 4 that the greater decrease in LAR responses is due primarily to the greater decrement in LAR scores for the HMA group under the rapid

Recall Scores for High and Low Aptitude Subjects on High/Low Association Word Pairs at Two Speech Rates



NOTE: The dotted lines mark baseline scores on the ordinate.

Figure 4

Table 9

Scores on High and Low Association Responses, by Aptitude and Listening Conditions

Mental Aptitude Group	Listening Condition					
	Baseline (0 wpm)		Compressed (375 wpm)		Normal (170 wpm)	
	HAR[a]	LAR[a]	HAR	LAR	HAR	LAR
HMA						
Mean	6.8	.5	10.0	3.9	13.3	10.7
SD	2.0	.6	2.2	1.9	2.6	3.9
LMA						
Mean	7.1	.7	7.5	2.7	10.7	7.2
SD	1.8	.7	2.1	2.2	3.7	3.5

[a]HAR = High Association Response; LAR = Low Association Response.

Table 10

Analysis of Variance: Effects of Aptitude and Speech Rate on Processing Information

Source	*df*	*MS*	*F*	*P*
Between Subjects				
Aptitude (A)	1	291.20	28.80	<.001
Speech Rate (B)	1	958.70	94.83	<.001
AB	1	22.02	2.18	NS
Error	88	10.11		
Within Subjects				
Association (C)	1	852.26	209.40	<.001
AC	1	1.44	<1	NS
BC	1	54.35	13.35	<.001
ABC	1	11.43	2.81	<.10
Error	88	4.07		

speech condition. This interpretation is supported by the fact that triple interaction approaches significance ($p<.10$). As expected, the main effects were all significant.

DISCUSSION

The data of Figure 4 indicate that, under the normal speech condition, both aptitude groups processed both HAR and LAR word pairs. In fact, the total correct scores for the HMA and LMA groups are made up of about the same percentage of LAR pairs, being 44.6 and 40.1 respectively. This suggests that both groups sampled the message in a similar manner, but the HMA subjects learned more of it.

An alternative to these findings would be to observe that subjects largely ignore the difficult word pairs, and approach nearly perfect performance on the easier word pairs. This strategy would involve "filtering" the difficult pairs. It seems likely that such filtering would more readily be observed under reading rather than listening conditions. This is because the persisting, spatial display of the printed page would permit rapid scanning and early determination that some materials would be easier to learn than others.

In listening, however, there is a non-persisting, temporally linear "display" which does not permit an early discrimination of easy from difficult materials. Under these conditions, it is reasonable that information processing would tend to follow the message, and hence all segments would be sampled indiscriminately. However, more difficult materials would be less likely to be learned as the forced pace of the listening material caused subjects to drop the encoding of one information unit and proceed to the next (or to ignore the next unit while dealing with the preceding unit).

A second observation in Experiment 4 concerns the differential effect of increasing the speech rate on the learning of HAR and LAR word pairs by the two aptitude groups. Although the HMA group learned more LAR word pairs than the LMA group at the normal speech rate, they learned almost the same number of LAR word pairs at the faster speech rate. Thus, the pressure induced by the acceleration of speech took its greatest toll on the ability of the HMA people to learn the more difficult associations.

This result is consistent with Rosenberg's (14) suggestion that HAR embedded in prose facilitates storage of information because they are recalled as pairs, while the LAR

word pairs are learned more as individual units. Hence, if the time per unit for learning is reduced, this will have a greater effect upon the learning of LAR than HAR. In the present study, the greater decrease in mean number of LAR word pairs recalled correctly by the HMA subjects under the compressed speech condition indicates that they were not being processed as efficiently as the HAR word pairs.

This experiment and the preceding one point out the usefulness of speech compression in investigations of individual differences in the processing of information presented through listening materials. By adjusting the compression ratio for a given set of learning materials, the performance of high aptitude subjects can be manipulated until it is approximately equal to the performance of low aptitude subjects who have listened to the materials at a normal rate of speech.

Once the performances for different aptitude groups have been equated, differences and/or similarities in type or kind of information transmitted can be investigated. This may lead to clues about individual differences in storage/retrieval strategies.

Another intriguing aspect of the use of time-compressed speech is that more information can be presented in a given amount of time. For example, if a message is time-compressed by 50%, it is possible to present the compressed version two times in the same amount of time required to present the uncompressed version once. A second alternative is that extra information may be presented in the time saved by the compression process. These possibilities form the basis for the research reported in the next experiment.

EXPERIMENT 5

THE COMPREHENSION OF ADDITIONAL INFORMATION PRESENTED IN THE TIME SAVED BY TIME COMPRESSION OF AUDIO TAPES

In previous work (17), time-compressed, tape-recorded messages were used to determine whether listening to the compressed message twice, in the same amount of time required to listen to the uncompressed message once, would improve listening comprehension scores of high and low mental aptitude men.

For both groups of subjects, the results indicated that listening twice to the compressed tapes improved comprehension over that obtained by listening to the compressed tapes only once. However, the comprehension of repeated time-compressed messages was not improved over that obtained with a single listening to the uncompressed messages. Similar results have been reported by Fairbanks, Guttman, and Miron (18), Jester and Travers (19), Friedman, Graae, and Orr (20), Woodcock and Clark (21, 22), and Hopkins (23).

To date, research seems to indicate that using the extra time resulting from the time-compression of materials to simply repeat information is not likely to improve learning over what could be obtained by listening once to the uncompressed message presented within the "normal" range of speech rate. Furthermore, the work of Fairbanks, Guttman, and Miron (18) suggests that listening twice to the *uncompressed* message is not likely to produce very drastic improvements in comprehension—if any at all. Possibly the effectiveness of repeated time-compressed messages may be increased for subjects who are trained in listening to time-compressed speech, but there is no firm data to suggest this (cf. 20).

A second possibility which has been mentioned for improving the efficiency of learning by listening is to use the time saved by the compression of material to present additional information. Fairbanks, Guttman, and Miron (24) used the time saved resulting

from 30% (201 wpm) compression of a message to emphasize certain portions of the message. As they pointed out, this amounts to trading temporal redundancy for verbal redundancy. Their results indicated that the reinforcing of certain parts of the selection did, indeed, increase the comprehension of the emphasized materials. This increase, however, appeared to occur at the expense of the remaining, unemphasized content, for the comprehension of this material showed a highly significant decline. Thus, the overall comprehension score for the reinforced, compressed material was less than the overall score for the uncompressed material.

Fairbanks and his associates suggested that emphasizing certain parts of the message may have led the subjects to assume that verbal redundancy meant "important to learn" and hence such emphasis may have selectively focused attention upon certain parts of the message, while diminishing attention to the remainder of the material. This suggests that if the time saved by the compression process was used to present additional, *new* information, perhaps an overall increase in the amount learned in a given unit of time might occur. The present research was performed to test this hypothesis.

METHOD

Subjects

One hundred and fifty Army inductees served as subjects. Seventy-five of the men had AFQT scores of less than 30, forming a low mental aptitude (LMA) group. The remaining 75 men had AFQT scores of 80 or above and formed a high mental aptitude (HMA) group. In terms of intelligence, these groups represent men having IQs of 90 or below and 120 plus, respectively (5).

Materials

The tape-recorded message used in this experiment was the "Roland" selection from the standardized listening passages prepared by Clark and Woodcock (25). The message was prepared at a normal, uncompressed speech rate of 178 words per minute. The time required to listen to the entire, uncompressed message was 15 minutes. For the purposes of the present research, five modified versions of the recording were prepared to constitute five experimental conditions. In one version, the message was presented at the normal, uncompressed speech rate of 178 wpm. However, the listening time was restricted to only 6'4".

By means of the time sampling compression method, two time-compressed versions of the foregoing message were prepared. One version was compressed by 36%, which produced a speech rate of 278 wpm, and reduced the listening time from 6'4" to 3'53". The second compressed tape was at 53% compression. This resulted in a speech rate of 378 wpm, and reduced the listening time from 6'4" to 2'52".

Thus, three versions of a message were available, having speech rates of 178, 278, and 378 wpm and for which listening time decreased from 6'4", in the case of normal speech, to 3'53" at 278 wpm and 2'52" at 378 wpm. These tapes were used to assess the effects of increasing the speech rate upon the comprehension of a recorded message, while holding the message content constant.

Two additional tapes were prepared at 36% time compression (278 wpm), and 53% time compression (378 wpm). In these tapes, however, the total listening time was held constant at 6'4". Thus, these tapes presented the same information as the three tapes described above, *plus* additional information in the time saved by the compression process.

Procedures

For the five experimental conditions represented by the five versions of the listening selections, comparable, independent groups of high and low aptitude subjects were assigned as listeners. Subjects were assigned in an unsystematic manner, as they became available, until all treatment cells were filled to an N of 15. The subjects listened to the tapes in an ordinary classroom. They were seated in a semicircle around a tape recorder adjusted to a "comfortable" listening level determined by the group.

The subjects listened first to the recorded instructions on the standardized listening tapes. Then they listened to the "Roland" selection. Immediately after the presentation of the listening selection, Form A of the comprehension tests, which contains 28 four-alternative multiple-choice questions, was administered by both reading and listening.

In the present research, the 6'4" of listening time presented at a normal (178 wpm) speech rate provided answers relevant only to the first 14 (50%) of the 28 test items. This was true also for the two compressed versions in which the speech rate was 278 or 378 wpm and the listening times were 3'53" and 2'52" respectively. For the compressed versions in which the listening time was held constant at 6'4", information relevant to both the first and second halves of the comprehension test was presented. In this case, information relevant to 23 (82%) of the test items was presented at 278 wpm, and information relevant to all 28 (100%) test items was presented at 378 wpm.

Of primary interest was whether holding the listening time of the compressed selections equal to that of the uncompressed message—hence presenting more information relevant to the criterion test—would result in an overall increase in scores on the criterion test.

RESULTS

The results of the study are summarized in Figure 5, comparing scores for the conditions for which the listening time was constant at 6'4" and for which listening time was reduced. The data indicate that under those conditions in which the speech rate was increased and the listening time was reduced, comprehension decreased for both high and low aptitude subjects. This is the typical finding regarding the relationship between speech compression and comprehension (3).

The data of primary interest showed that the listening time was constant at 6'4", while the speech rate was increased from 178 to 278 to 378 wpm. Thus, more information relevant to the criterion test was presented with the faster rates of speech. The data of Figure 5 indicate that, for both low and high aptitude men, there was no increase in comprehension scores over those for the uncompressed message when more information relevant to the test was presented at the accelerated speech rates.

For lower aptitude men, there is a suggestion that listening to additional information at accelerated speech rates may have improved comprehension over that obtained by listening to less information at the same accelerated speech rates. However, the differences indicated in Figure 5 are not statistically significant.

DISCUSSION

These data indicate that listening to additional information in the time saved by the time-compression of speech may not lead to increased learning. In the present study this was true even for material compressed only 36% and presented at 278 wpm, and even though this compression resulted in a higher "listening efficiency" score, that is, more

Scores for High and Low Aptitude Subjects for Time-Compressed/Time-Limited or Time-Compressed/Time-Extended Selections

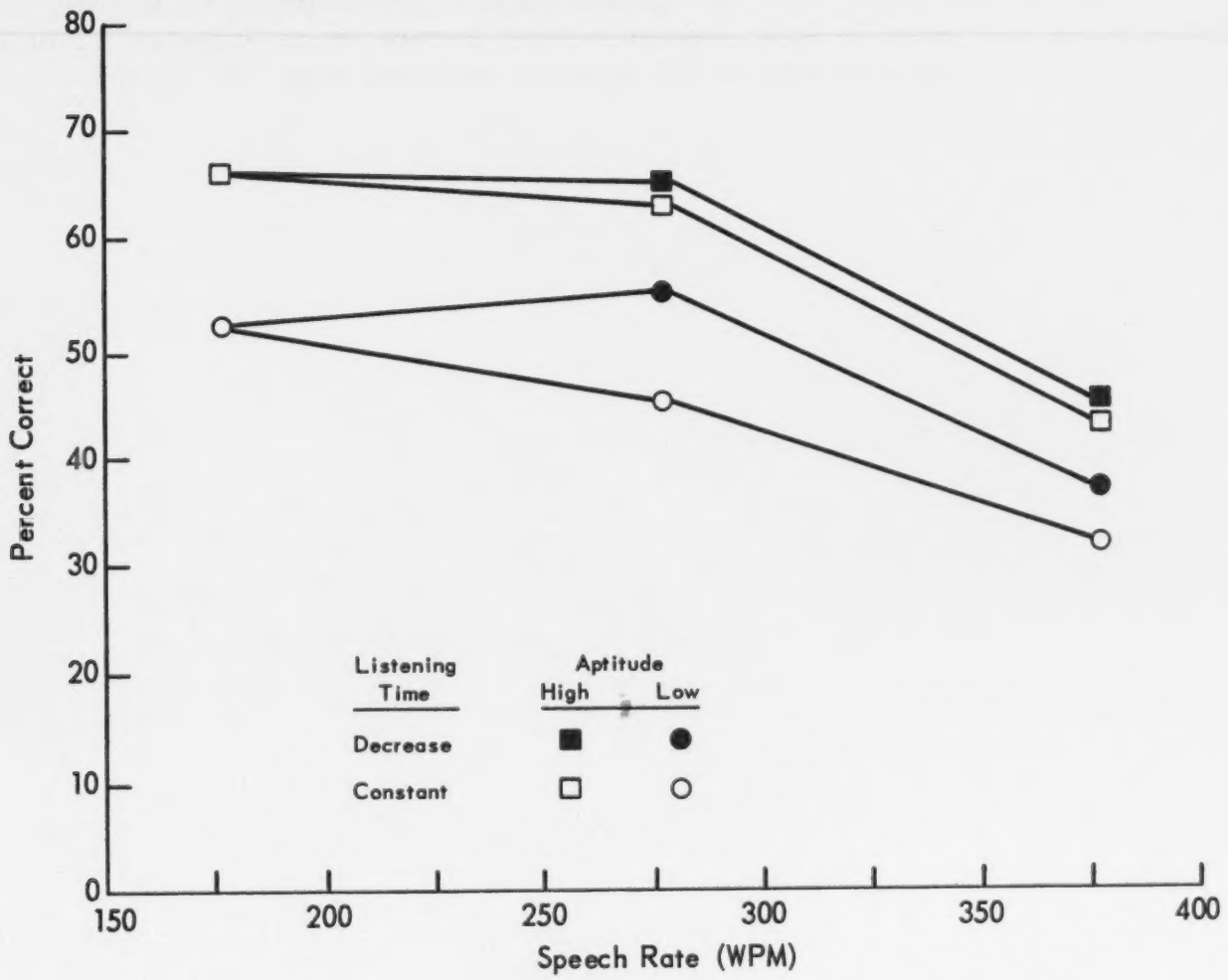


Figure 5

was learned per unit of time spent listening, than with the normal (178 wpm) rate of speech. This was true for both aptitude groups.

As mentioned earlier, Fairbanks, Guttman, and Miron (24) attempted, but failed, to increase learning by using the extra time resulting from 30% compression to emphasize certain content in a recorded message. They suggested that emphasizing certain content might have caused the subjects to consider that content as more important than the remaining content, and hence they may have ignored the unemphasized materials. They also mentioned the possibility that the response to the emphasized version of the message may have actively inhibited the response to the unemphasized content.

The present results are essentially the same as those found by Fairbanks and colleagues. But in the present case, the possibility of selectively focusing attention through emphasis of materials was avoided and hence does not explain the failure to find improved learning with extended listening.

The notion of inhibition, however, may be related to the present findings. An analysis of the responses of high aptitude subjects to the first and second halves of the 28-item test indicated that, with the materials presented at 278 wpm, the scores on the first half of the test decreased slightly when the message was 6'4" in duration as opposed

to when the message length was only 3'53" in duration. Thus, there is the possibility that retroactive inhibition may have occurred, such that listening to additional material may have interfered with the retention of previously presented material. However, the evidence for this is very slight. Also, this interpretation is not confirmed by the data for the low aptitude men who, in fact, showed a slight increase in performance for both halves of the test when listening time at 278 wpm was extended from 3'53" to 6'4".

Part III

SUMMARY AND DISCUSSION

COMMENTS

To recapitulate briefly, several research studies have attempted to demonstrate that the time saved by time-compression might be used to increase learning over that which could be obtained by listening once to the uncompressed materials. These studies have used the time saved by the compression process to repeat or review messages (17, 18, 20, 21, 22), to selectively elaborate parts of messages (24), or to present additional new, but related information (the present research). To date, none of these techniques has been found to significantly increase the amount of learning over that obtained from a single presentation of the same, or unelaborated, or less extensive material presented in an uncompressed format with speech rates between 140-178 wpm.

On the basis of these limited data, it appears that the technique of trading time for information has not resulted in more information being processed by the listener for short-term retention. Most significantly, this has been true for materials compressed to speech rates of 275-300 wpm for which listening "efficiency," that is, the amount learned per unit of listening time, has actually been higher than obtained with "normal" materials. Thus, the implication has yet to be substantiated that because of improved listening efficiency more information can be learned in a unit of time with moderate compression.

It should be mentioned, however, that there are several features of the various research efforts under consideration that serve to limit conclusions to be drawn from them. First, practically all of this research has involved listeners untrained in listening to compressed speech.

Second, in each of the studies, materials within a given subject-matter area, such as, meteorology, were presented in both the compressed message and in the time saved by compression of the materials. The probability of interference factors might be reduced if a different type of content was presented in the time saved by the compression process.

Third, these studies have presented the additional information in a single sitting and immediately tested for learning. Perhaps some spacing of the presentation of new compressed information might increase learning over that obtained by continuously listening for the same amount of time to uncompressed materials (but see 20 for negative findings using long-term intervals between *repetitions* of materials).

As a final comment upon the efficiency of learning from moderately time-compressed speech, it should be pointed out that the experiments reported here all have been concerned with using the time saved by the time-compression process for increasing the learning of a given group of subjects. An alternative would be to use the time saved for other purposes, such as instructing additional students. Many studies, including the present one, have demonstrated that much learning can occur with materials that have been compressed by 30-40%. Clearly the time saved can be used to instruct additional listeners. Thus, the efficiency of time-compressed listening does not rest solely on demonstrating an increase in the amount of learning per group per unit of time, but also by the demonstration that more groups per unit of time can be instructed with moderate compression.

DISCUSSION

This discussion includes a general summary of the basis for concern with listening in Work Unit REALISTIC. Information about listening obtained in a variety of studies in REALISTIC, including those described in the present report, is summarized. Finally, selection, training, and research implications of these studies, and the work of others, are discussed.

THE STUDY OF LISTENING IN WORK UNIT REALISTIC

Work Unit REALISTIC has had two major objectives: (a) the identification of literacy skills adequate for satisfactory performance in selected Army jobs, and (b) the exploration of methods for reducing gaps between job literacy demands and the literacy skill levels of personnel available for the job. In pursuit of these objectives, a considerable amount of information has been obtained related to listening behaviors and abilities of military personnel. The work leading to this information about listening was initiated for two reasons.

First, in attempting to evaluate the need for literacy skills in job performance, it was anticipated that the performance of many job tasks would not require reading skills either because of the inherent nature of the task, or because men could be (and would have been) taught to perform the task by "listen, look, and learn." For example, it was anticipated that mechanics might learn to repair a carburetor by being told what to do rather than by using the appropriate manual. Thus, whereas it seemed likely that reading per se might not be demanded for performance (or learning to perform) a task, it seemed less likely that listening ability would not be involved—at least at the learning stage. Hence, job listening behavior was included as a component of literacy in the REALISTIC work.

A second reason for interest in listening as a literacy skill concerned the objective of reducing the gap between personnel literacy skills and literacy demands of Army jobs. Because skill in listening is prerequisite to learning to read (with the exception of the deaf), it was considered that some persons lacking in reading skills sufficient to deal with certain job performance or training requirements might be able to satisfy those requirements if the demand for reading were replaced by listening. For example, prose materials presented in textbooks might be recorded on audio tape as listening materials, thus freeing the learning task of reading demands.

FINDINGS ON LISTENING FROM REALISTIC

The research on listening performed in Work Unit REALISTIC can be categorized into four groupings: (a) studies of listening as a job skill; (b) reading versus listening as learning processes; (c) characteristics of listening materials related to learning by listening, and (d) research to increase the amount learned by listening in a fixed amount of time. The research findings in each of these categories are summarized below.

Listening as a Job Skill

To better understand the importance of listening for job performance, mechanics, cooks, and supply clerks were interviewed at their job sites regarding the extent to which they used reading (manuals, charts, etc.) and listening (peers, supervisors) sources to obtain job information (26).

Results indicated that, for mechanics and supply clerks, men reading in the grades 4.0-6.9 range tended to rely as much (or more) on listening sources as on reading sources for job information. Men with better reading ability relied less on listening and more on reading sources for job information. It was also found that the cook's job involved reading materials much less difficult than the mechanic's or supply clerk's jobs, and there was markedly more use of reading relative to listening as a source of job information, even for the poorer reading cooks.

Thus, the on-the-job interviews indicated that, where reading materials are difficult, men of poor reading ability rely heavily upon listening as a basic source of job information. Conversely where materials are written at the level of the user, whether weak or strong reader, he will tend to use them.

Further indication of the importance of listening as a job skill was obtained by comparing the job proficiency of men of differing listening abilities working as armor crewmen, mechanics, supply clerks, and cooks (27). Significant correlations were obtained in all jobs between listening and job knowledge (paper-and-pencil) tests and job sample tests, that is, tests in which men performed actual samples of work: cooks cooked, mechanics repaired vehicles, and so forth.

With regard to the work sample tests, listening skill predicted performance as well as reading or AFQT did. Furthermore, within a restricted range of AFQT scores (0-30), listening ability predicted job sample performance as well as the full range of AFQT scores did. Thus, listening ability appears to be a useful dimension for additional screeening of Army inductees.

Both the on-the-job interviews and the intercorrelations of listening and job proficiency have underscored the importance of listening as a job literacy skill. We were also concerned with determining how reading and listening might compare as processes for learning of job information.

Reading vs. Listening as Learning Processes

To compare the relative effectiveness of learning by reading or by listening, the same prose materials were prepared as either reading or listening test passages (1). Men of low mental aptitude (AFQT scores 10-30) and of higher mental aptitude (AFQT scores greater than 30, with a mean of 63) were administered the reading and listening test materials, which included materials of grade levels 6.5, 7.5, and 14.5 (Flesch readability scores). With reading time limited to that available for listening, the men in both aptitude groups learned as well by listening as by reading.

To find out who might prefer to learn by listening rather than by reading, the survey described in Part I of this report was conducted. As indicated, preference for learning by listening increased with decreasing reading ability (and decreasing AFQT). This is consistent with the results of the on-the-job interviews which indicated that lower reading ability mechanics and supply clerks learned much of their job information by asking (listening to) others rather than by reading.

Thus, these studies indicate that large numbers of lower ability men (a) prefer to learn by listening, (b) *do* rely on listening on the job, and (c) learn by listening as well as by reading. This suggests that many types of prose materials could be effectively prepared as listening materials so that those who preferred to learn by listening might do so.

Characteristics of Listening Materials Related to Comprehension

This report and an earlier one (1) present research concerning the effects of various aspects of listening materials upon comprehension. Two studies have indicated that, as materials decrease in readability, as assessed by means of a readability formula, they are more difficult to comprehend for both high and low aptitude (AFQT) men. Also, as

shown earlier, low association strength word pairs are not learned as well as high association strength word pairs embedded in sentences.

Additional work (4) indicated the importance of certain linguistic and acoustic cues to meaning in learning by listening. In that research it was found that the listening comprehension of high aptitude men increased monotonically as the listening conditions were varied from no message (baseline), to presentation of the message with the words individually spoken and presented in random order, to presentation of the words individually spoken but sequenced into a meaningful story, and finally to a normal, prose-like version of the message containing inflection, pausation, and rhythmical cues to meaning.

In conjunction with the research concerning the structural aspects of the listening message, considerable attention has been given to the rate of presentation of the message (1, 4, 17, and this report). In general, this work has indicated that increasing the rate of speech reduces the comprehensibility of the message, although this reduction is usually negligible for speech rates up to around 250 wpm (with variability due to the task demands). Experiments 3 and 4 in the present report suggest that the effects of varying the speech rate may be different for HMA and LMA subjects, depending upon the nature of the listening materials. But there is insufficient evidence for suggesting generalization in this regard.

It is safe to say, however, that, for both HMA and LMA subjects, increasing the rate of presentation of a message to above 300 wpm will almost certainly have a significant effect on comprehension. Viewed otherwise, however, these studies indicate that listening materials recorded in the "normal" range of speech rates (e.g., 125-175 wpm), can generally be compressed by as much as 20-30% without a large loss in comprehensibility. Thus, some trade-off is feasible: generally, a small loss in comprehension can be traded for what may be a considerable savings in time.

Research to Increase Learning by Listening in a Stated Time

The fact that listening time may be saved by the time compression of listening materials while producing only a small loss in comprehension suggests the possibility of using the time savings to improve the overall learning of the materials. This was attempted in a study in which compressed materials were presented twice in the same amount of time required to present the uncompressed message twice (17). While such repetition did restore the comprehension of compressed materials to normal, for both HMA and LMA subjects, overall learning was not improved.

In this report, Experiment 5 attempted to use the time saved by the compression process to present additional information, with the idea of increasing the total amount learned in a given amount of time. However, neither HMA nor LMA subjects learned a greater amount when extended, but compressed information was presented, over that which they learned when less, but uncompressed, information was presented.

Thus, the limited research to date has not been successful in using the time saved by the time compression procedure to improve learning over that obtained with non-compressed materials. However, shortcomings of this work are many, and the matter remains a viable problem for research.

IMPLICATIONS IN SELECTION AND TRAINING

Selection

Listening performance was as effective in predicting job sample performance within a restricted range of AFQT as the latter was over the full range of AFQT in three Army

jobs (27). This suggests that, for added precision in selecting potentially successful job performers, the administration of a listening test could be considered.

In our work on compressed, accelerated speech, it was found that some men could perform as well with speech rates of 375-400 wpm as others could at normal rates of speech. Others (28) have found that skills important in comprehending rapid speech may be different than those for comprehending normal speech. Possibly the use of rapid speech test materials might make it possible to better select men for training in languages or Morse code. Research is needed to explore the utility of rapid speech as a selection tool.

Training

The results of the studies reported herein and elsewhere (1) indicate that, where feasible, reading *and* listening materials should be available to students, so that men who learn better, or who prefer to learn by listening might do so. Furthermore, some moderate degree of compression might be accomplished, particularly for more able students, to reduce study time. If compression is used, it would be best restricted to "normal" prose material, with its fairly high redundancy.

Research is needed to determine the utility of the time saved by the compression of speech. At present, research evidence speaks against using this time to simply repeat the entire message or to add new information. Possibly, peak comprehension might be improved by selectively repeating or elaborating upon the more important aspects of the materials. It might also be useful to insert questions into the material to focus attention on upcoming or recently presented material.

In general, the importance of the speech sampling, rate variation technique for education and training is the technological feature of being able to expand or compress recorded materials. This makes possible the provision of listening rate options for a variety of students. In this regard, at the University of Missouri, compressed speech is employed in an Automated Message System accessed through dial telephones located in student laboratories (29). By dialing a particular number, students have a choice of listening to lectures, lecture summaries, or other special instructional messages at a slowly paced or compressed rate.

An additional technological feature is that recorded messages can be tailored to fit particular time frames. For example, a 45-minute briefing might be recorded for the information of command-level officers, but compressed to fit a 30-minute listening frame, perhaps with inexpensive cassette recorders located in their cars or offices. Many additional uses of rate-controlled recordings are suggested in the Newsletter of the Center for Rate Controlled Recordings.[7]

Finally, because of the importance of listening as a training and job literacy skill, research is needed to determine whether general improvements in listening ability might be accomplished through training in listening/thinking skills. Such work is underway in HumRRO Work Unit LISTEN.

[7]Center for Rate Controlled Recordings, University of Louisville, Louisville, Kentucky 40208.

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